



HISTORICAL SPACE WEATHER DATASETS (SA33A-1988)

W. F. Denig¹, Justin Mabie^{2,1}, Karen Horan¹ and Craig Clark¹

The National Geophysical Data Center (NGDC) is primarily responsible for scientific data stewardship of operational space weather data from NOAA's fleet of environmental satellites in geostationary and polar, low-earth orbits. In addition to this and as the former World Data Center for Solar Terrestrial Physics from 1957 to 2011 NGDC acquired a large variety of solar and space environmental data in differing formats including paper records and on film. Management of this heterogeneous collection of environmental data is a continued responsibility of NGDC as a participant in the new World Data System. Through the former NOAA Climate Data Modernization Program many of these records were converted to digital format and are readily available online. However, reduced funding and staff have put a strain on NGDC's ability to effectively steward these historical datasets, some of which are unique and, in particular cases, were the basis of fundamental scientific breakthroughs in our understanding of the near-earth space environment. In this talk, I will provide an overview of the historical space weather datasets which are currently managed by NGDC and discuss strategies for preserving these data during these fiscally stressing times.

¹NOAA/NESDIS/National Geophysical Data Center (NGDC), 325 Broadway, Boulder, CO 80305 [william.denig@noaa.gov]

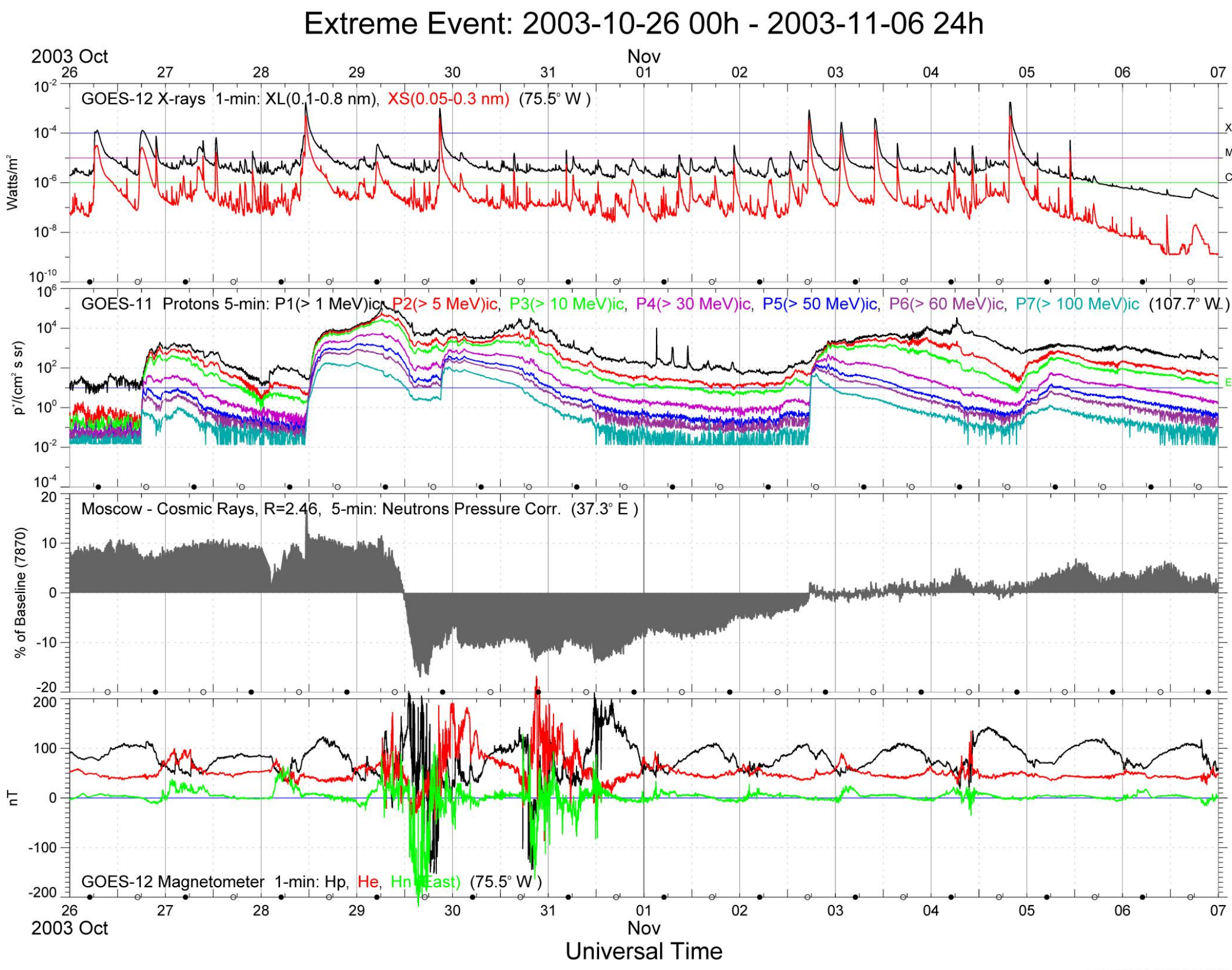
²Cooperataive Institute for Research in Environmental Sciences (CIRES), University of Colorado at Boulder, Boulder, CO 80309



BACKGROUND

The organizational roots for NGDC can be traced back to the National Bureau of Standard's Inter-service Radio Propagation Laboratory formed in 1942 to provide ionospheric information and data for assured communications. During the 1950s the mission for NGDC was enhanced to include solar and geophysical effects, the operational monitoring of which is now the responsibility of the NWS Space Weather Prediction Center (SWPC). For the 1957-58 International Geophysical Year (IGY) NGDC was designated as the World Data Center (WDC) for Airglow and the Ionosphere. The founding principle for the WDC system was to foster the non-restricted international exchange of geophysical data by establishing data repositories who's overall archive functions were to acquire, manage and disseminate environmental data and information. Subsequent to the IGY and throughout the 1960s the functions of WDCs for Aurora (University of Alaska and Cornell University), Cosmic Rays (University of Minnesota), Solar Activity (University of Colorado) and Upper Atmosphere Geophysics (Aeronomy and Space Data Center) were coalesced into the WDC for Solar-Terrestrial Physics (Boulder) within the NGDC Solar Terrestrial Physics (STP) division. In 2009 the World Data Center system was disbanded and subsequently replaced with the World Data Service in recognition of the profound changes that have occurred both in international data exchange and the electronic availability of environmental data.

In response to these dramatic changes, the mission of STP has shifted from that of a world-wide data repository to that of a provider of environmental data acquired from NOAA and USAF operational space weather assets. However, a balance needs to be maintained between the historical foundations of the organization and future directions which best serve NOAA constituents. To this end, STP data holdings include datasets of both historical value and active interest.



Extreme Space Weather Event – GOES

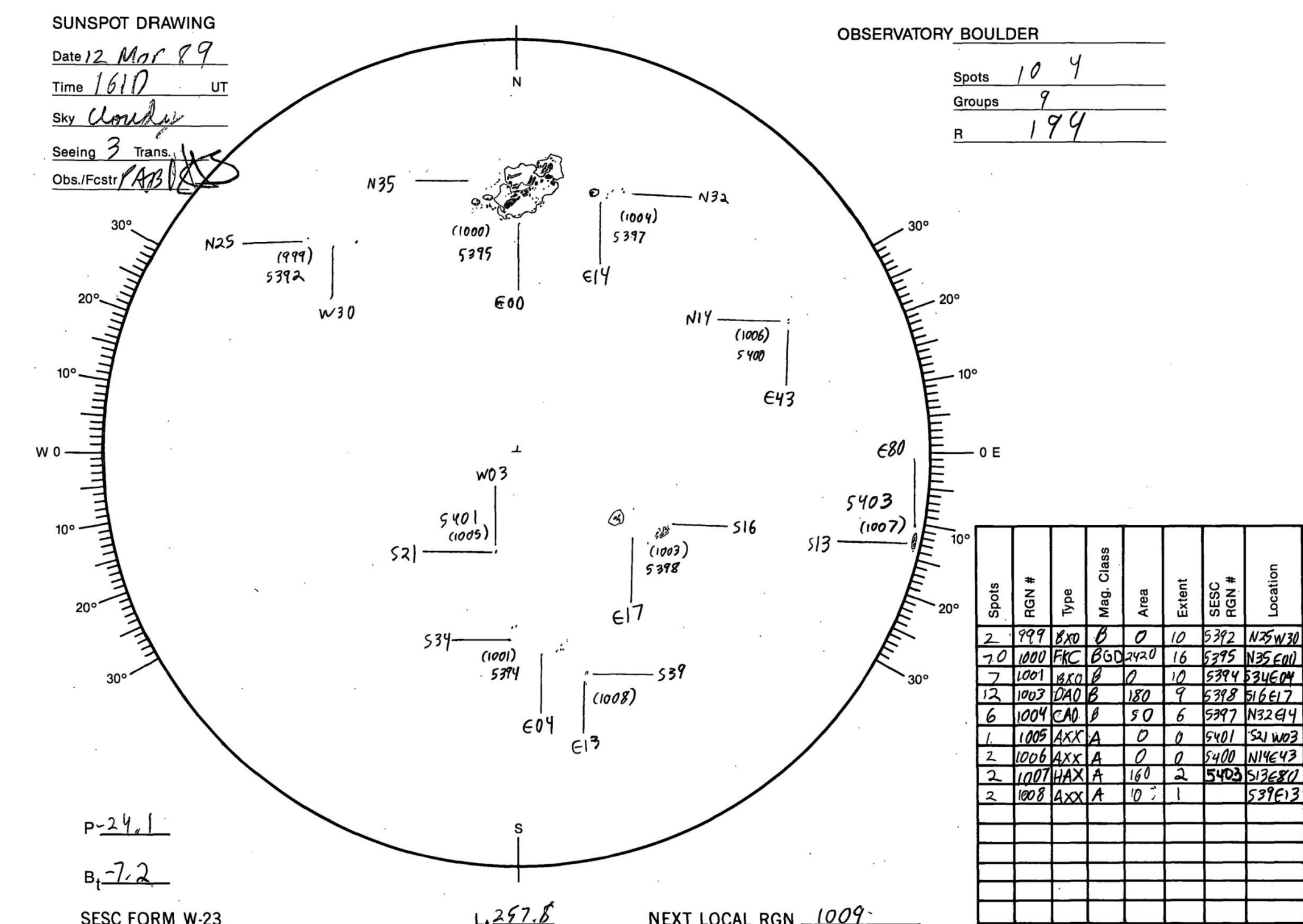
CURRENT OPERATIONAL DATASETS

NGDC acquires space weather data from NOAA's operational fleet of satellites in [GEO](#) (left, above) and in polar [LEO](#) (right). Data from these systems (including predecessor spacecraft) are available, respectively, from 1974 and 1978 to present. Also included in the archives are space

weather (SWx) data from the [Defense Meteorological Satellite Program](#) (1987 – present) provided by the Air Force Research Laboratory. Both DMSP and the NOAA satellites are large capital investments in operational space weather systems which, despite their costs, provide only limited spatial coverage of the near-Earth space environment. NGDC manages a variety of other space weather datasets of historical value, some of which continue to be acquired today, at a fraction the costs of these aforementioned systems.

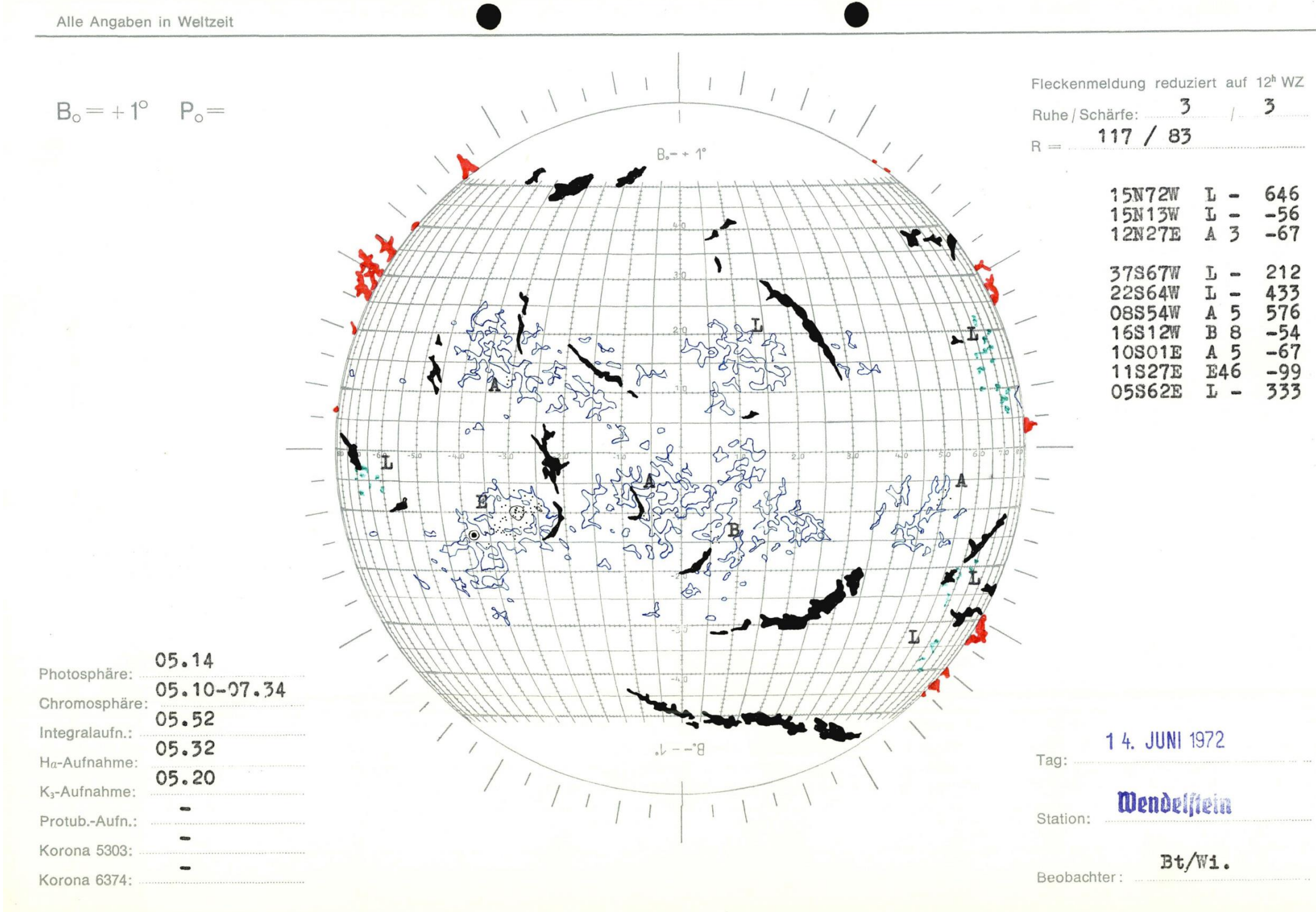
HISTORICAL SPACE WEATHER DATASETS

NGDC manages a variety of historical solar drawings and imagery that were provided from ground-based observatories, some of which are no longer in operation or have changed function. Early photospheric sunspot drawings from [Charles Schott](#) were made during a limited period of interest from 1859-60 inspired, no doubt, by the observations made by Carrington during the same interval. More extensive records exist from the solar observatories at [Kalocsa](#), Hungary (1880-1919); [McMath](#), Michigan (1942-1953); [Sacramento Peak](#), New Mexico (1947-2004); [Boulder](#), Colorado (1966-1992), and the [Solar Observing Optical Network](#) (1979-present). Through arrangement with the Royal Observatory, Greenwich, the complete publication record of [Photo-heliographic Results](#) (1874-1976) are also available from NGDC.



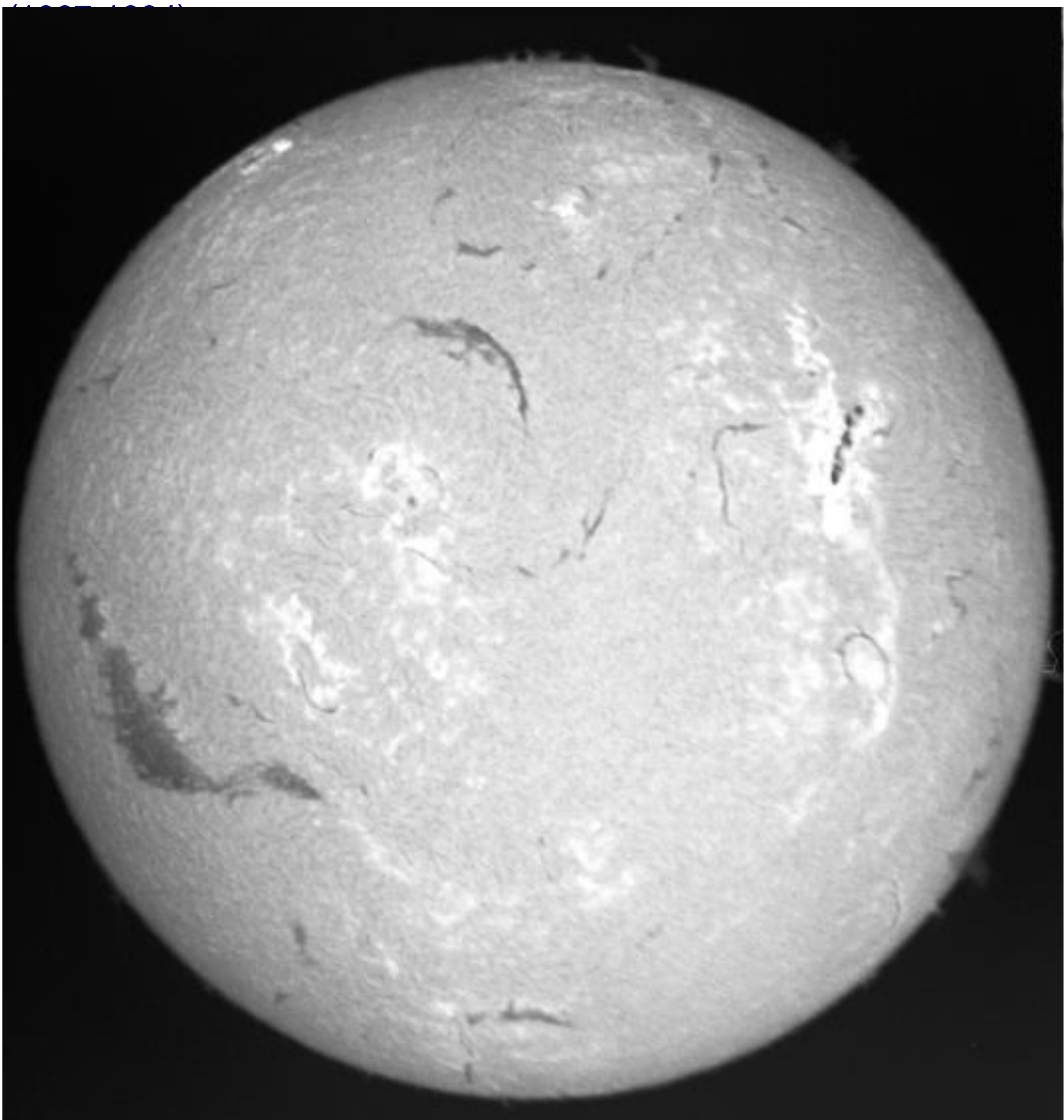
Boulder Sunspot Drawing – 12 March 1989

Daily synoptic drawings of the sun have been prepared by various observatories which describe the sun in much more detail than sunspot drawings alone. Typical synoptic drawings include the locations of active regions, filaments and prominences, coronal holes, and the solar magnetic structure. A particularly beautiful set of drawings were provided from the [Wendelstein Observatory](#), Germany (1947-1987) although other professionally prepared drawings are available from the [Fraunhofer Institute](#), Germany (1956-1973) and [Boulder](#) (1972-present) as well as records from the [International Geophysical Year](#) (1957-1958) and from [amateur solar gazers](#) (1958-1970). Additional synoptic information were included in Carrington rotation maps from [Sacramento Peak](#) (1989-2008), [Kislovodsk](#), Russia (1979-2012), [Kitt Peak](#), Arizona (2003-2012), and [Wilcox](#), California (1999-2010). These maps depict the magnetic topology or other solar spectral features of interest observed over the 27-day period.



Wendelstein Synptic Drawing – 04 June 1972

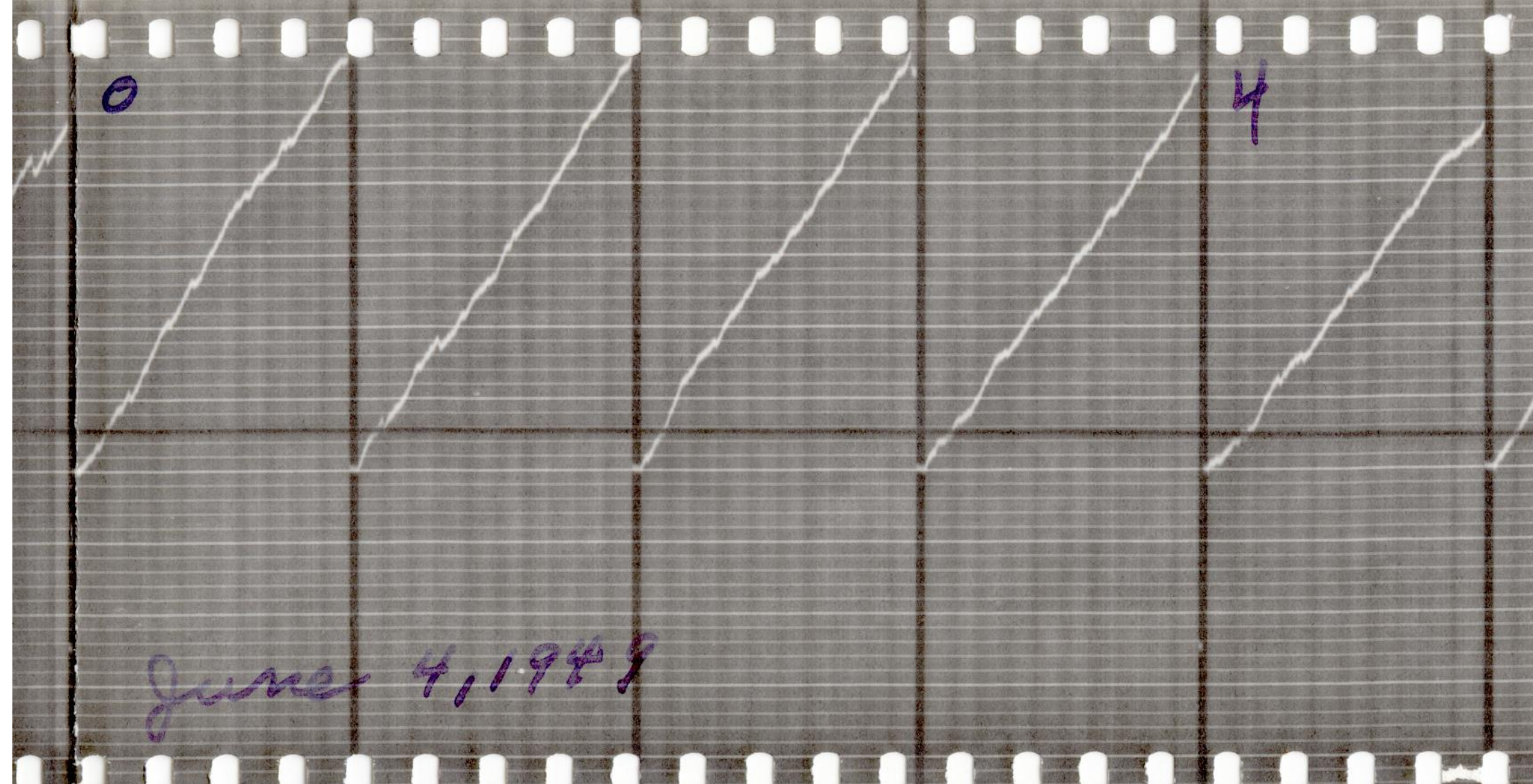
A variety of solar photographs are also available including assorted [while light](#) images (1946-2012) and filtered images, mostly in the [Calcium II](#) K-line (1915-2013) at 303.4 nm and [Hydrogen-alpha](#) (1967-present) at 656.3 nm. Whereas the white light images depict features such as sunspots and plage regions on the photosphere, the Calcium II and H-alpha photographs image the lower and mid-level chromosphere. Features within the chromosphere include filaments/prominences, plage and the chromospheric network. The image below is an H-alpha photograph from the [Boulder Observatory](#)



Boulder H-alpha Photograph – 12 March 1989

FORBUSH RECORDS

Scott E. Forbush (1904-1984) was an earlier pioneer in the field of study commonly referred to solar-terrestrial physics. A unique holding at NGDC is the original set of [Forbush Records](#) (1936-1968) which were obtained from the Carnegie Institute in 2006. Records from the cosmic ray stations at Huancayo (1936-68), Cheltenham/Fredericksburg (1936-68), Christchurch (1947-61), Godhavn (1947-59) and Mexico (1957-58) have been mostly digitized and are available although only a sample of data is currently online. A 5-hour snippet of data from station Godhavn for 04 Jun 1949 is show below where the rate of rise in the number of counts (y-axis) is an indication of the cosmic ray background.



OTHER DATASETS AND ONLINE PUBLICATIONS

NGDC also provides tabular lists of space weather events provided by ground-based observatories, including [H-alpha solar flares](#) (1938-present), [solar radio bursts](#) (1960-2010) and [sudden ionospheric disturbances](#) (1958-2010). Also included are the various records of sunspot numbers from providers, including the World Data Center for [Sunspot Index and Long-term Solar Observations](#) (1818-present), [American Association of Variable Star Observers](#) (1944-present) and the [Rudolf Wolf Society](#) (2011-present).

Monthly compilations of relevant geophysical data are included in the [Solar Indices Bulletin](#) (1995-present) and the [Geomagnetic Indices Bulletin](#) (1985-present) which are prepared by NGDC using data acquired from numerous providers. Additionally, the historical record of space weather is contained in the reports of [Solar-Geophysical Data](#) covering the period from 1955 to 2009. Key space weather events, such as that which occurred in August 1972, are summarized in the [Upper Atmospheric Geophysics](#) reports published between 1968 and 1996.

SUMMARY

NOAA is an operational agency responsible for acquiring and managing environmental data and information. The Solar & Terrestrial Physics division within NGDC stewards a large variety of solar and geophysical products acquired from NOAA observing systems and from national and international data providers. Whereas current interests include data from NOAA's fleet of environmental satellite, the focus of this talk has been on those other data sources, mostly ground-based, which provide the historical context of space weather. Much of these data were acquired as paper and film records which have been converted to digital form and are now available [online](#).

Acknowledgements – NGDC appreciates the datasets that have been provided to NOAA. We also acknowledge the Climate Data Modernization Program through which many of the historical paper and film records have been converted to digital formats.